Consumer hedonic studies with incomplete block designs

J. C. Castura
Compusense Inc.

Compusense®

Acknowledgements

Thanks to **Brian Franczak** (MacEwan Unversity, Edmonton, Alberta, Canada) and **Chris Findlay** (Compusense Inc., Guelph, Ontario, Canada) for helpful discussions.

Thanks to **Josef Zach** (Ipsos Marketing, Munich, Germany) for the invitation to join this workshop and for providing the workshop data set.

Some Takeaways

Data is not Good just because it is Complete

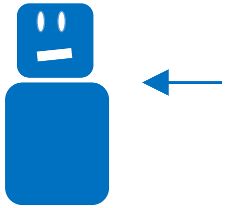
- It is “the devil we know”
- Consumer responses change as the test progresses
- Sometimes less is more…

Data is not Good just because it is Incomplete

- Impact of first-position effect is more pronounced
- Sometimes less is less…

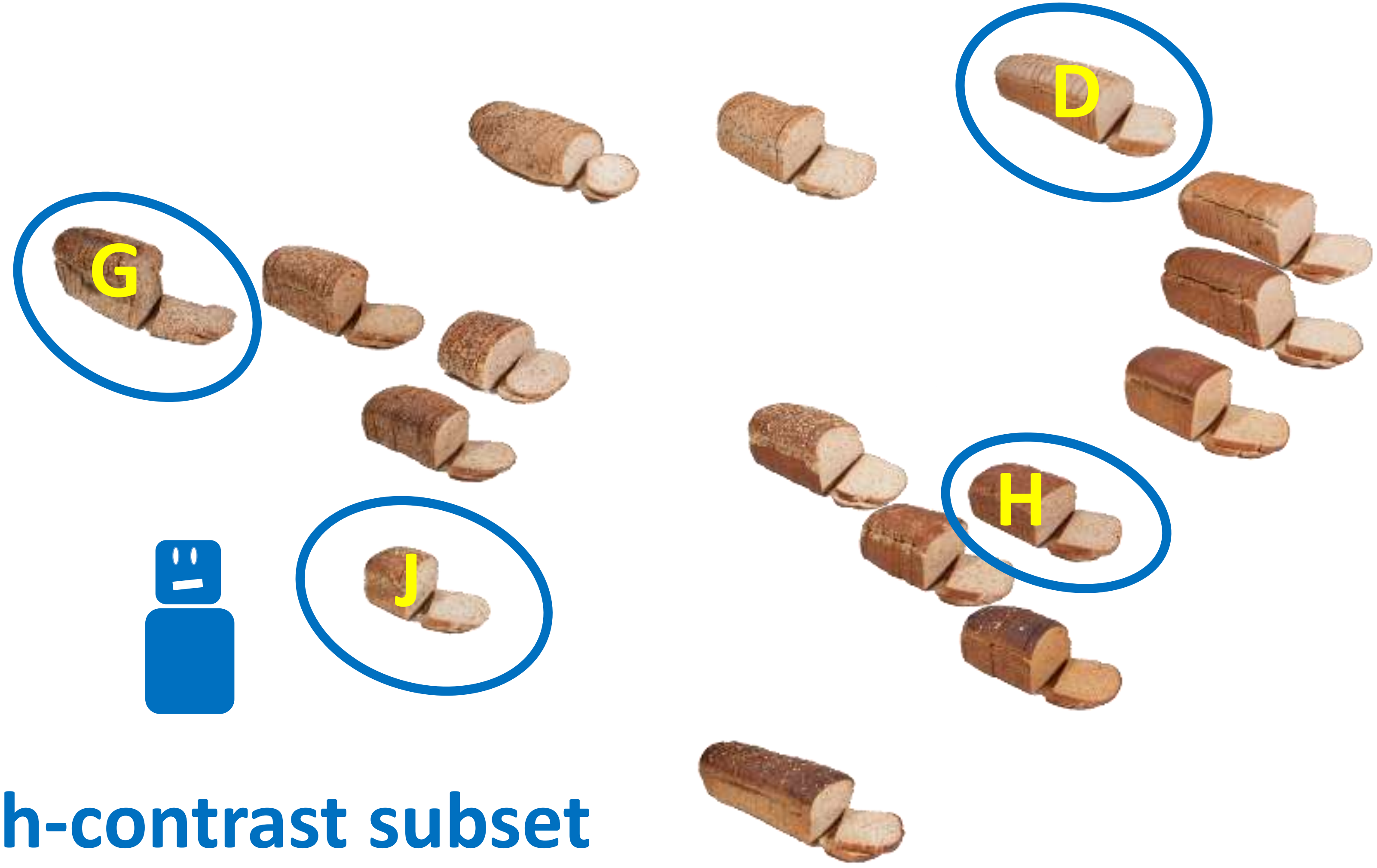
Sensory space

Balanced incomplete block design



F	A	I	D
B	C	E	I
H	E	J	B
I	F	C	A
E	B	H	C
G	**J**	**D**	**H**
A	D	F	G
C	I	B	F
D	G	A	J
J	H	G	E
D	C	G	B
I	H	F	J
B	G	C	D
A	B	D	E
…	…	…	…

Balanced incomplete block design



A high-contrast subset

Balanced incomplete block design

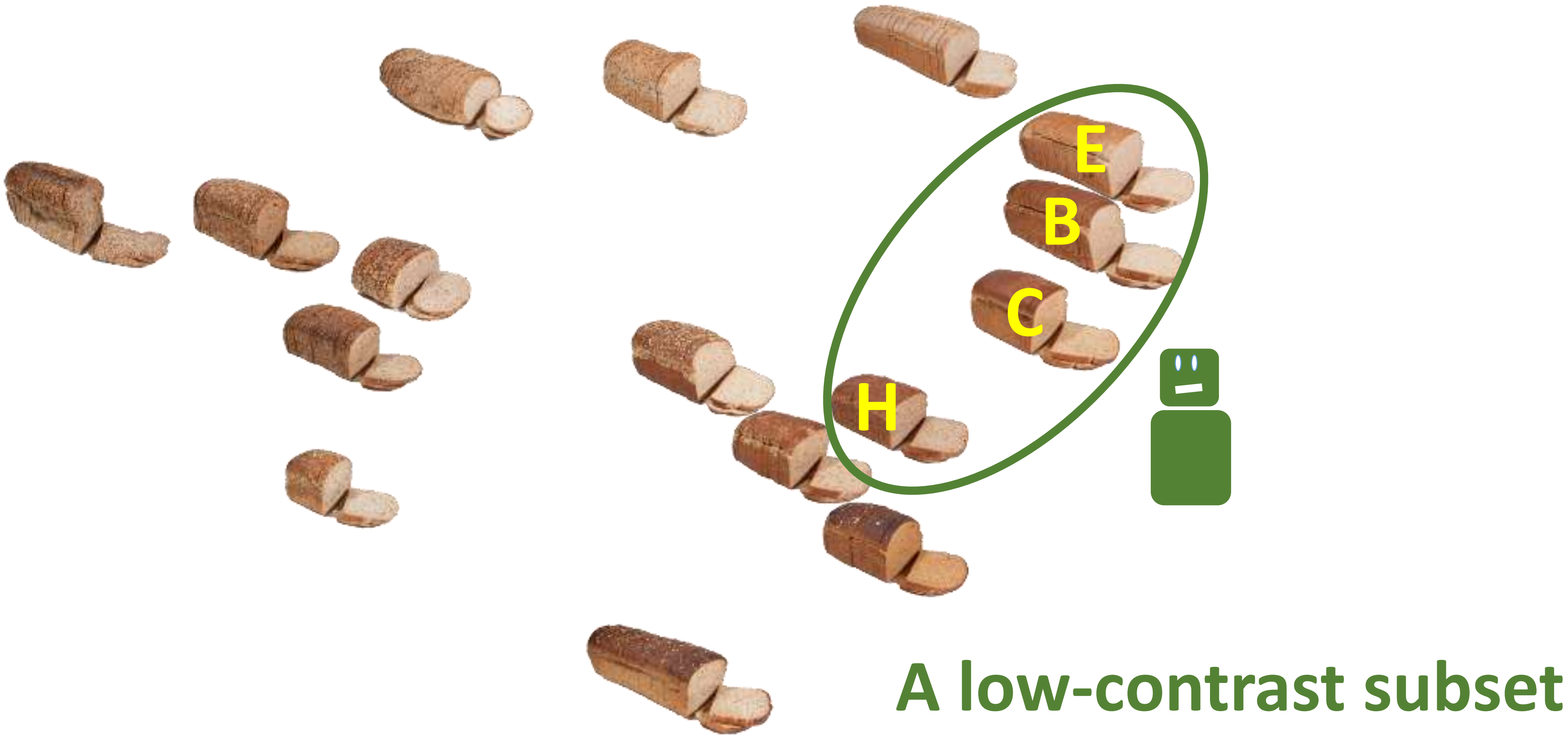
Hedonic responses are given for a wide range of products.
From these few responses we learn a lot about this consumer's preferences.

A high-contrast subset

Balanced incomplete block design

F	A	I	D
B	C	E	I
H	E	J	B
I	F	C	A
E	**B**	**H**	**C**
G	J	D	H
A	D	F	G
C	I	B	F
D	G	A	J
J	H	G	E
D	C	G	B
I	H	F	J
B	G	C	D
A	B	D	E
…	…	…	…

Balanced incomplete block design



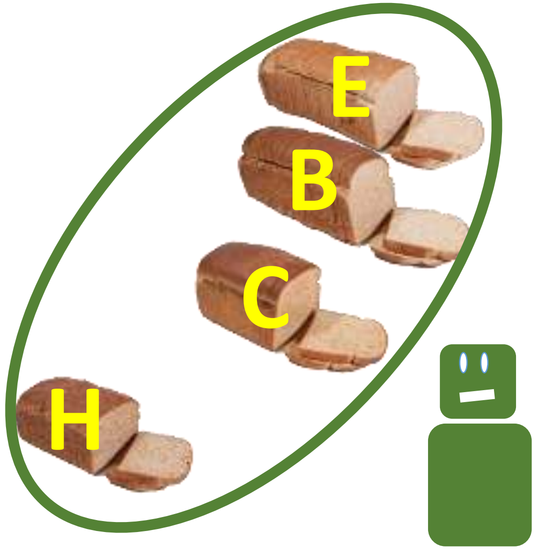
Balanced incomplete block design

Hedonic responses are given for a narrow range of products.
So we learn little about this consumer's preferences.

A low-contrast subset

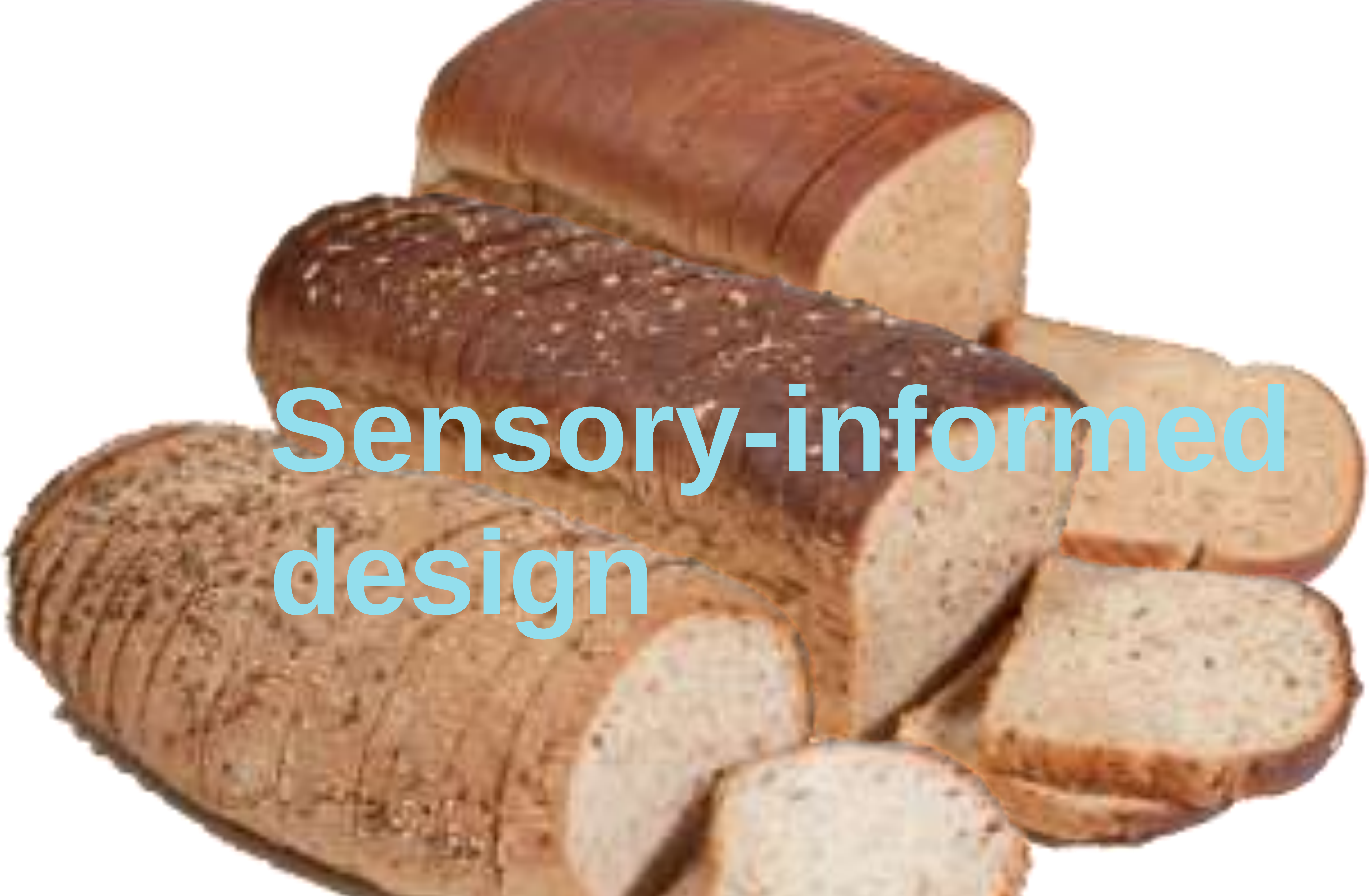
Balanced incomplete block design

Would this product have been liked or disliked ?

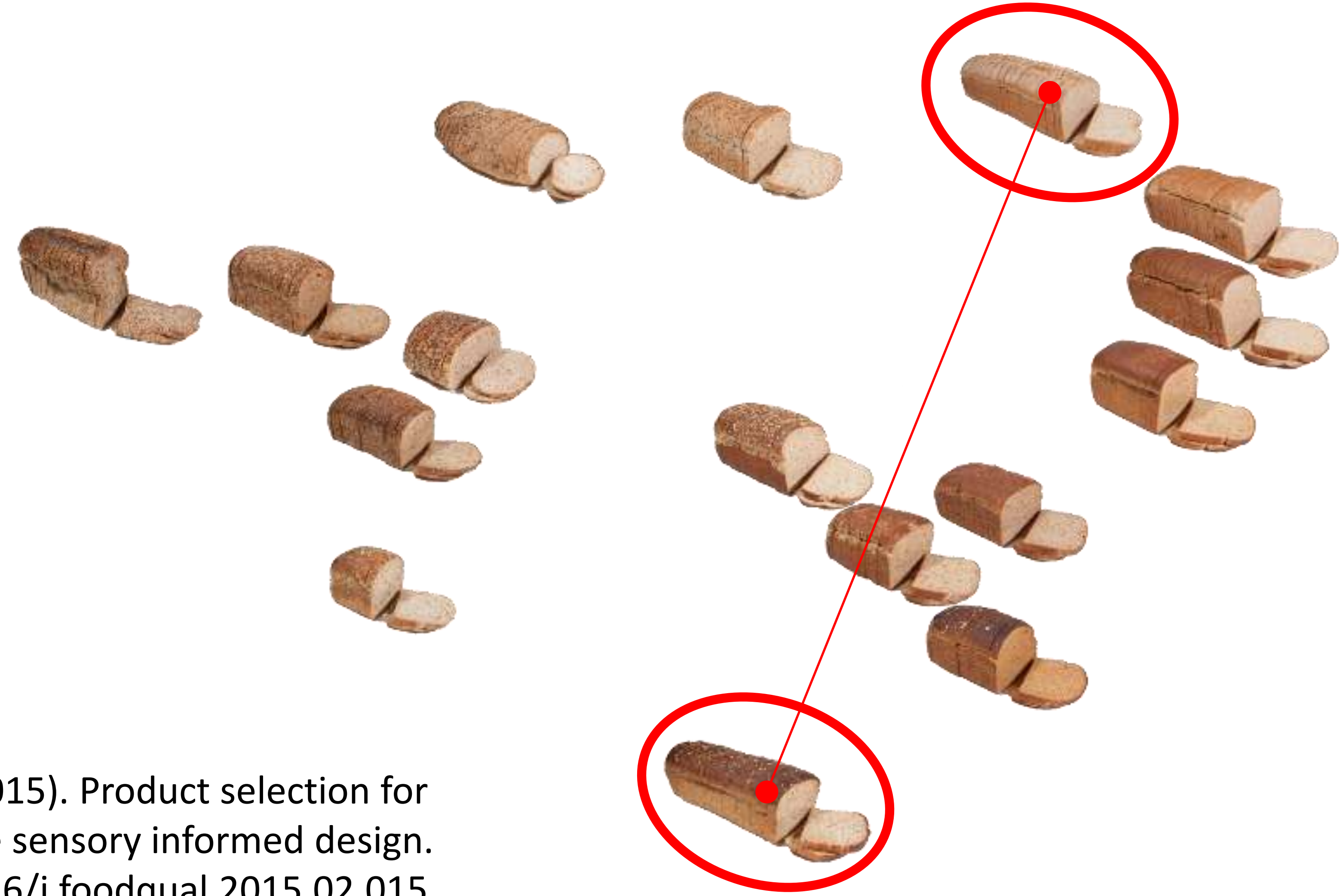


A low-contrast subset

Sensory-informed design

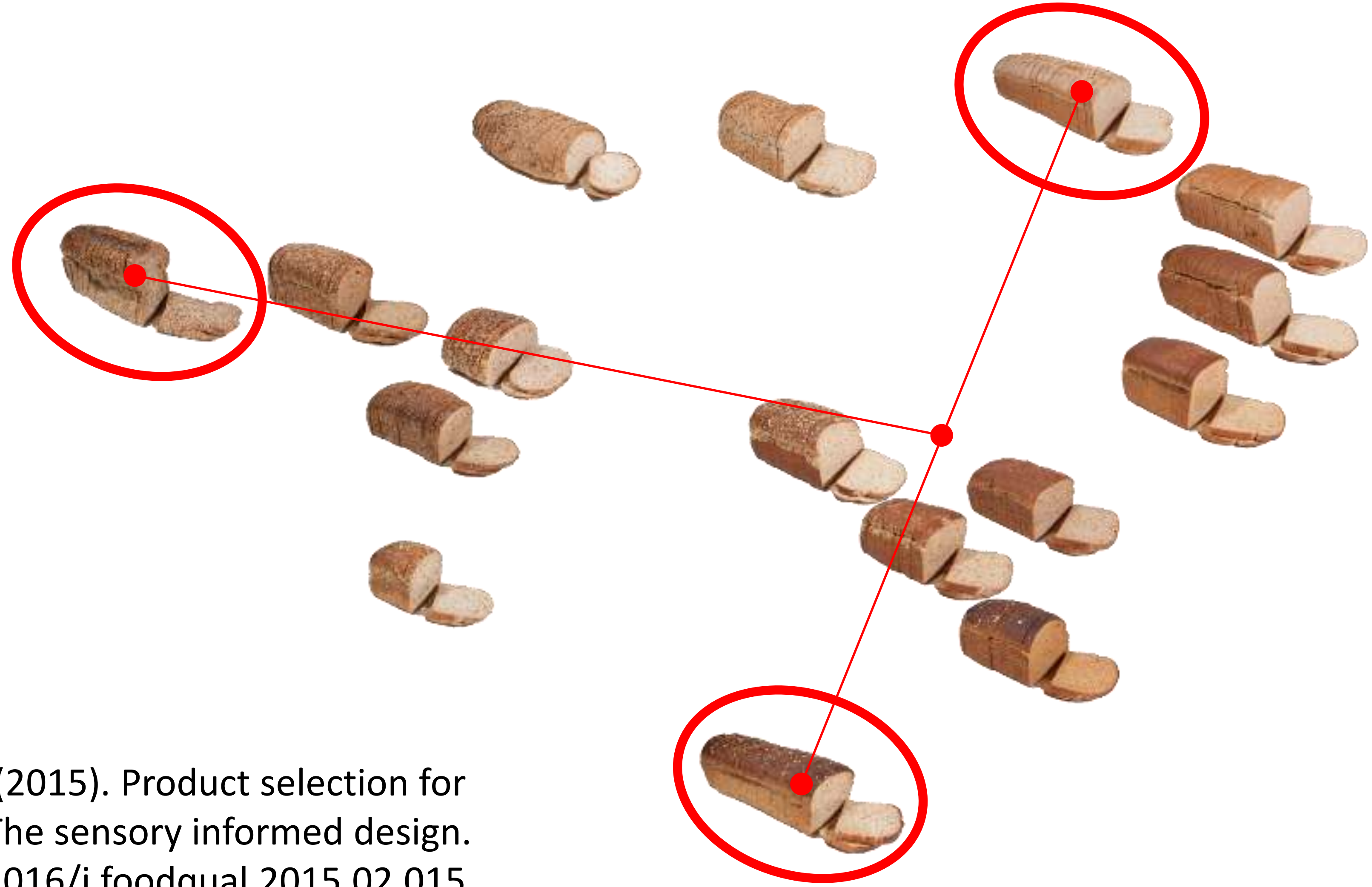


Sensory-informed design



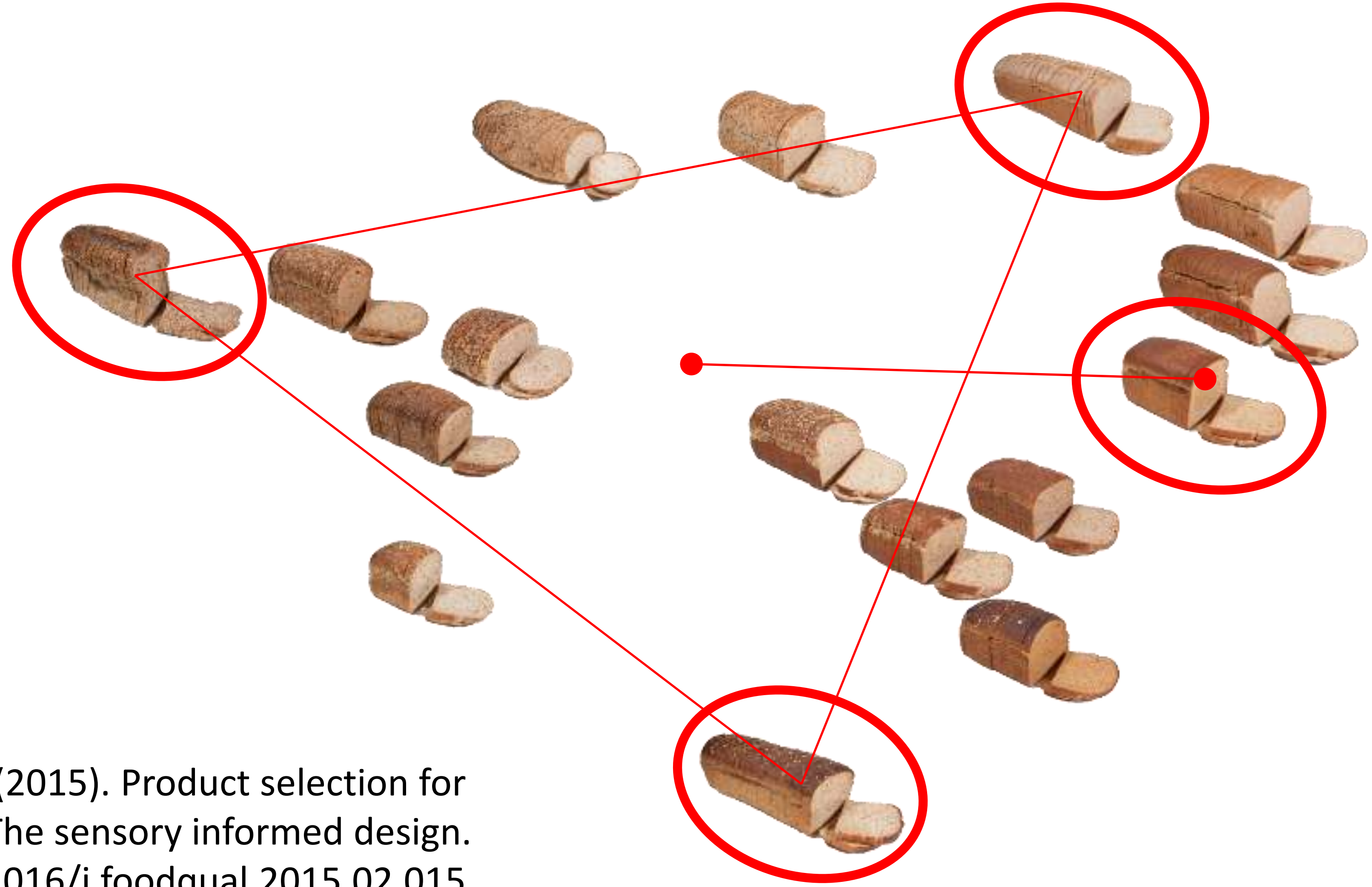
Franczak et al. (2015). Product selection for liking studies: The sensory informed design. *FQAP*, doi: 10.1016/j.foodqual.2015.02.015.

Sensory-informed design



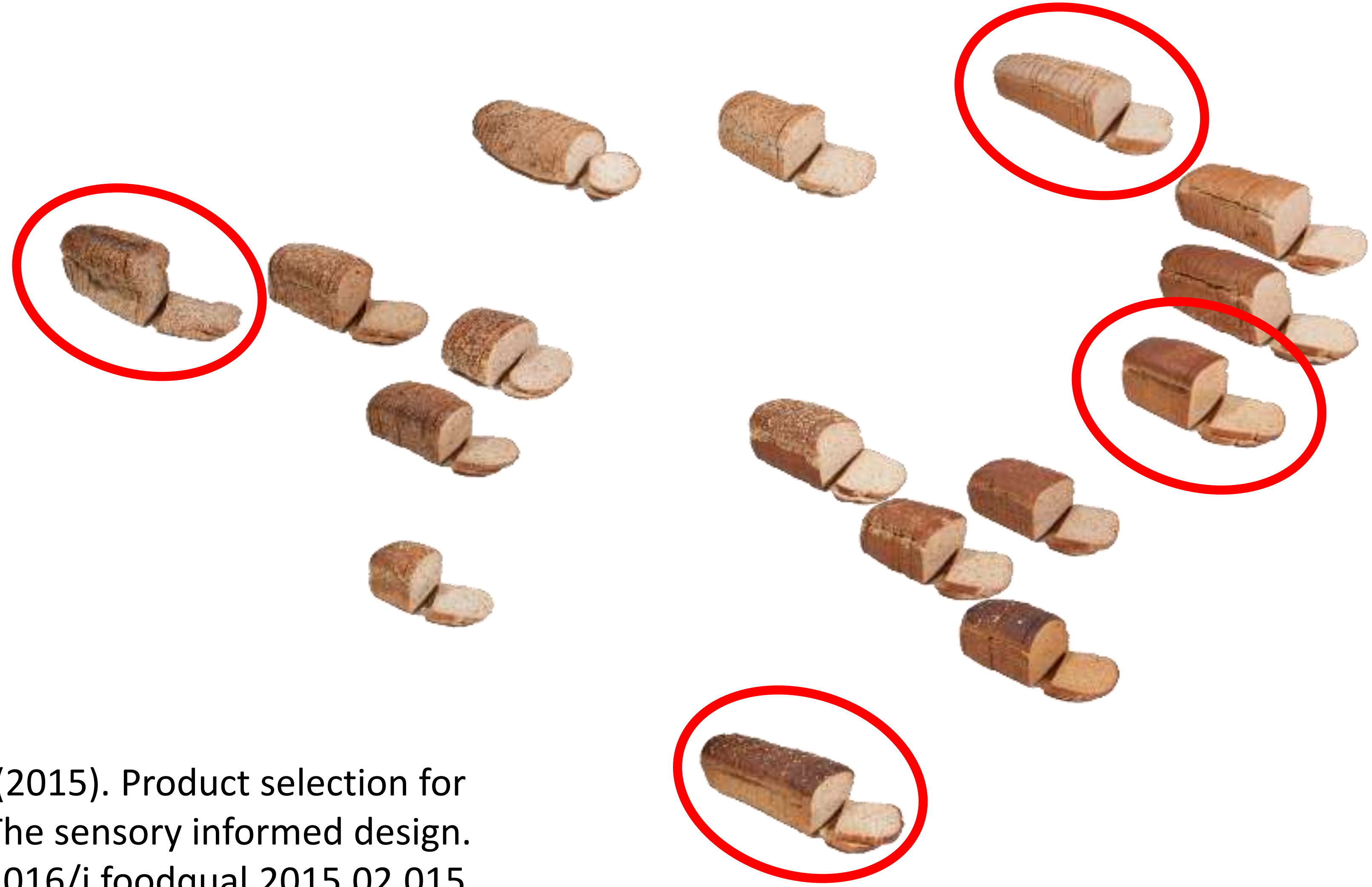
Franczak et al. (2015). Product selection for liking studies: The sensory informed design. *FQAP*, doi: 10.1016/j.foodqual.2015.02.015.

Sensory-informed design



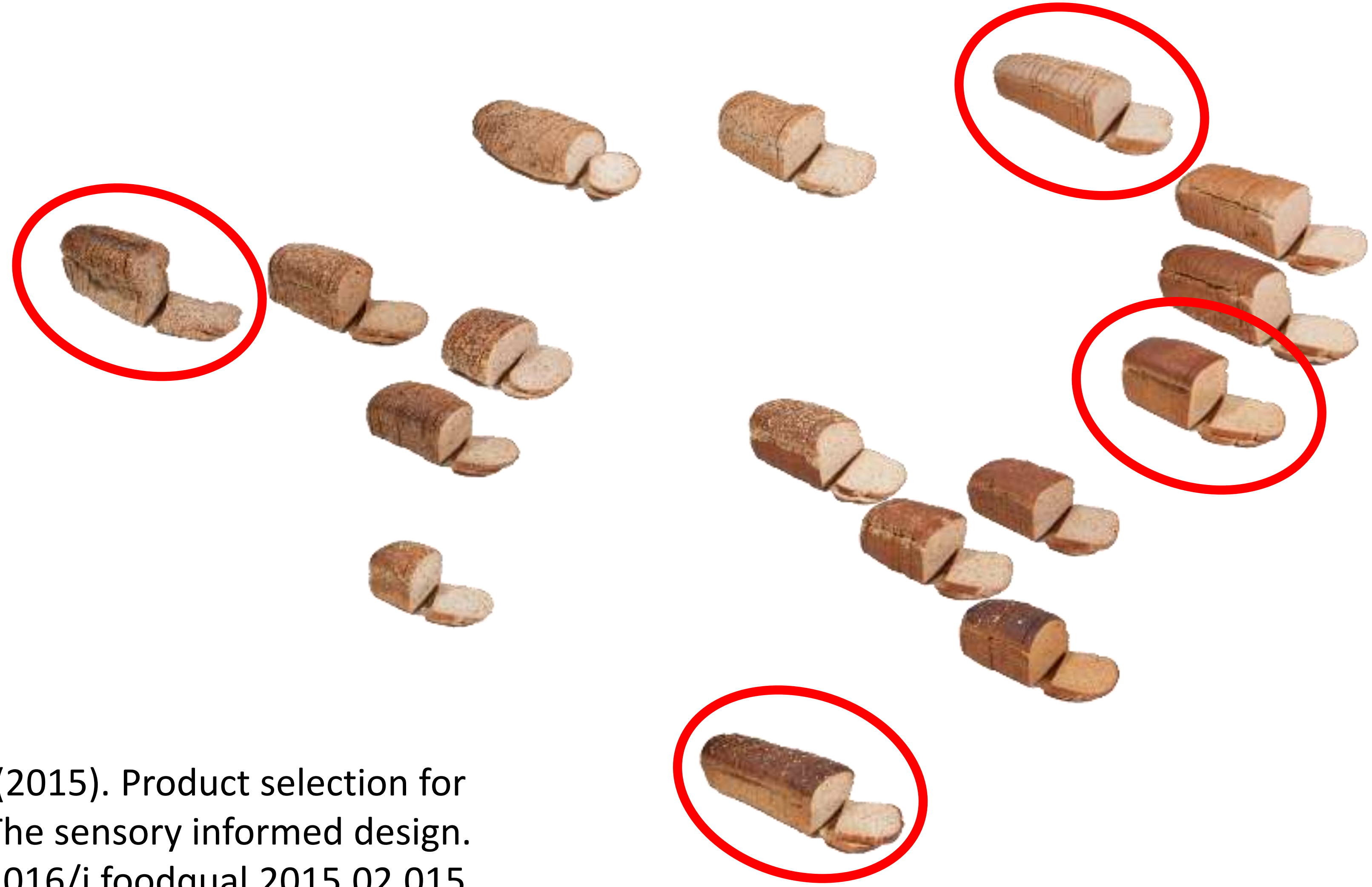
Franczak et al. (2015). Product selection for liking studies: The sensory informed design. *FQAP*, doi: 10.1016/j.foodqual.2015.02.015.

Sensory-informed design



Franczak et al. (2015). Product selection for liking studies: The sensory informed design. *FQAP*, doi: 10.1016/j.foodqual.2015.02.015.

Sensory-informed design



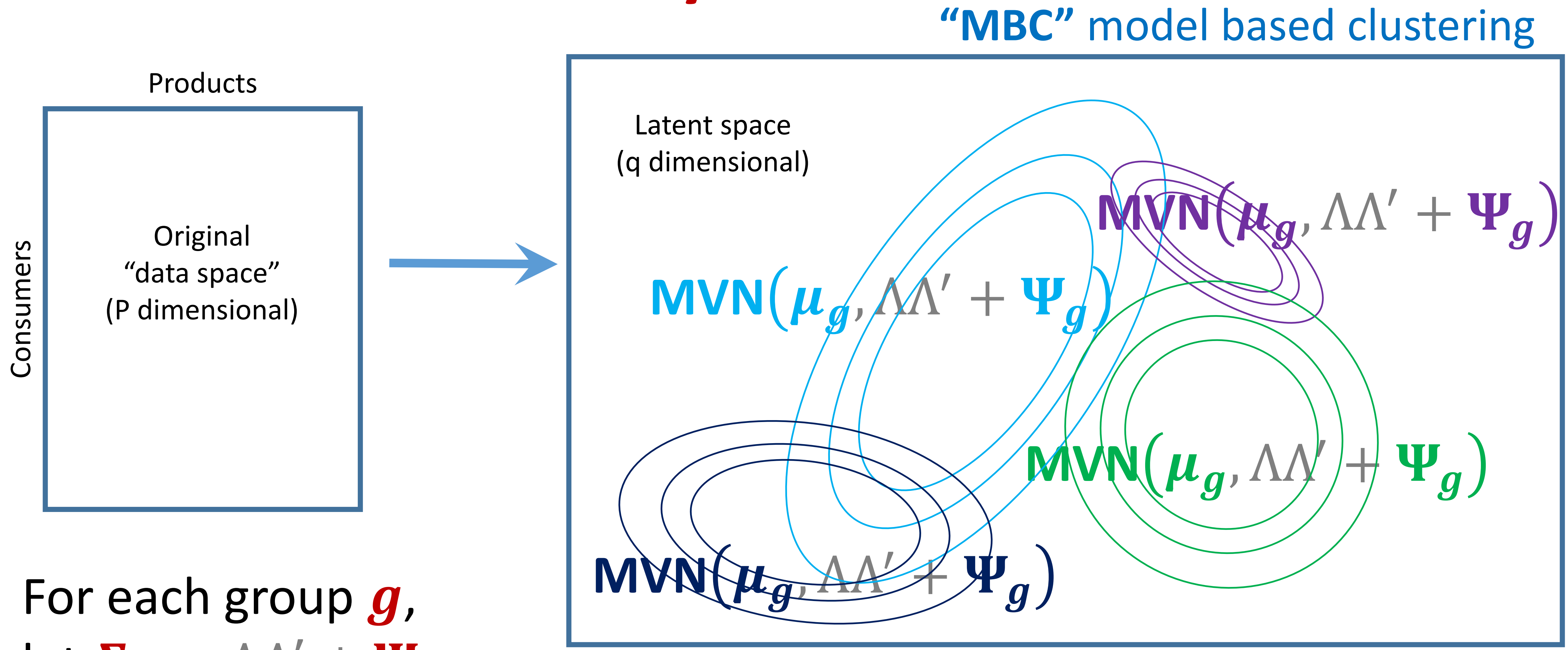
Order balanced

Every subset has reasonably high contrast

(…in as many dimensions as is relevant..)

Franczak et al. (2015). Product selection for liking studies: The sensory informed design. *FQAP*, doi: 10.1016/j.foodqual.2015.02.015.

Mixture of factor analyzers

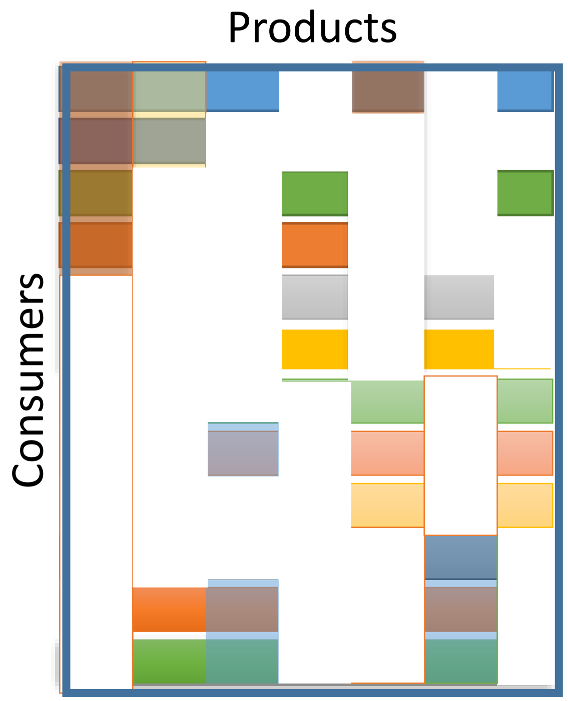


For each group $\boldsymbol{g}$,

let $\boldsymbol{\Sigma}_{\boldsymbol{g}} = \Lambda\Lambda' + \boldsymbol{\Psi}_{\boldsymbol{g}}$,

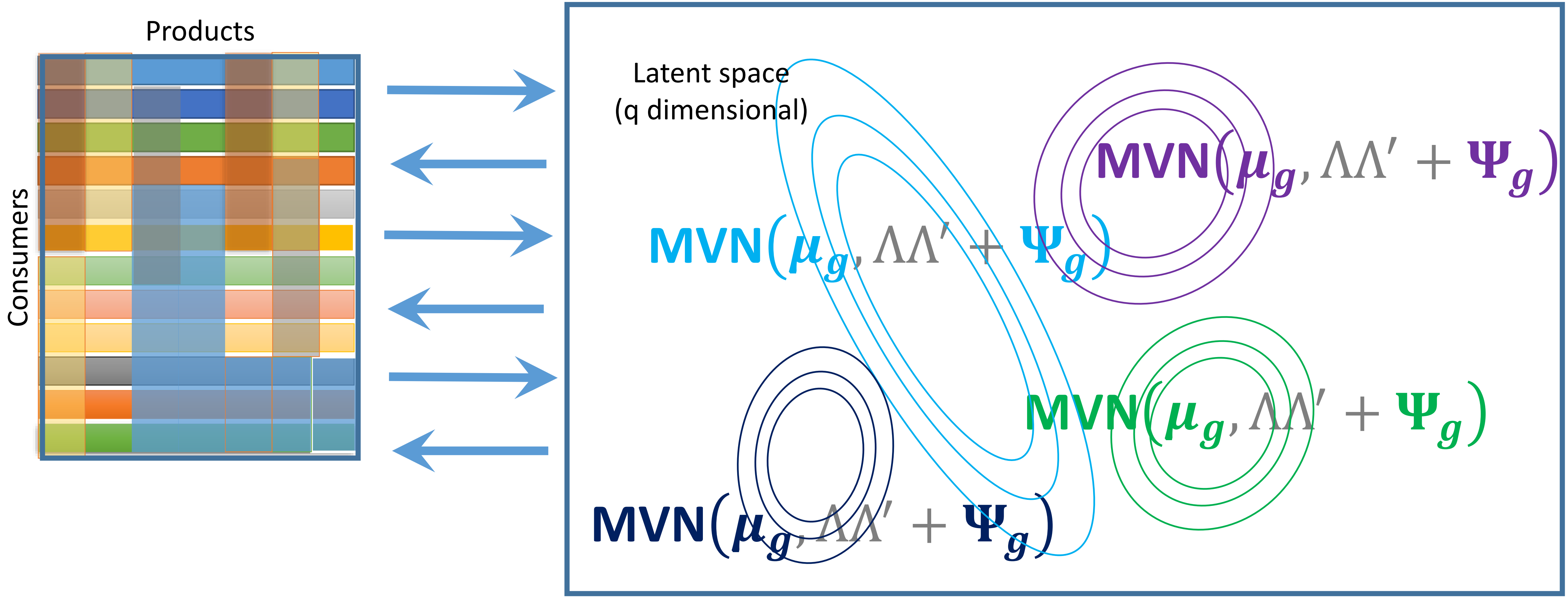
where Λ is a common loading matrix (shared by all groups).

Model-based clustering + clusterwise imputation



Browne, R.P., McNicholas, P.D., & Findlay, C.J. (2013). A partial EM algorithm for clustering white breads. *arXiv preprint arXiv:1302.6625*.

Model-based clustering + clusterwise imputation



“MBC + Imputation”
model based clustering and imputation

Browne, R.P., McNicholas, P.D., & Findlay, C.J. (2013). A partial EM algorithm for clustering white breads. *arXiv preprint arXiv:1302.6625*.

Sensory-informed design

What are the benefits?

Faster! … Cheaper! … Better?

Will it work for every product category?

Will it work for ***my*** product category?

It depends…

Risk comes from not knowing what you are doing.*

Samples need to span the relevant sensory space

- Relevant sensory space cannot be too complex
- Samples must span attributes that drive the hedonic response
- Needs to be enough samples presented (not too many… not too few…)

Must be a high enough signal-noise ratio

- Tricky if products are too variable
- …or if order effects are too strong

Need good design and analysis

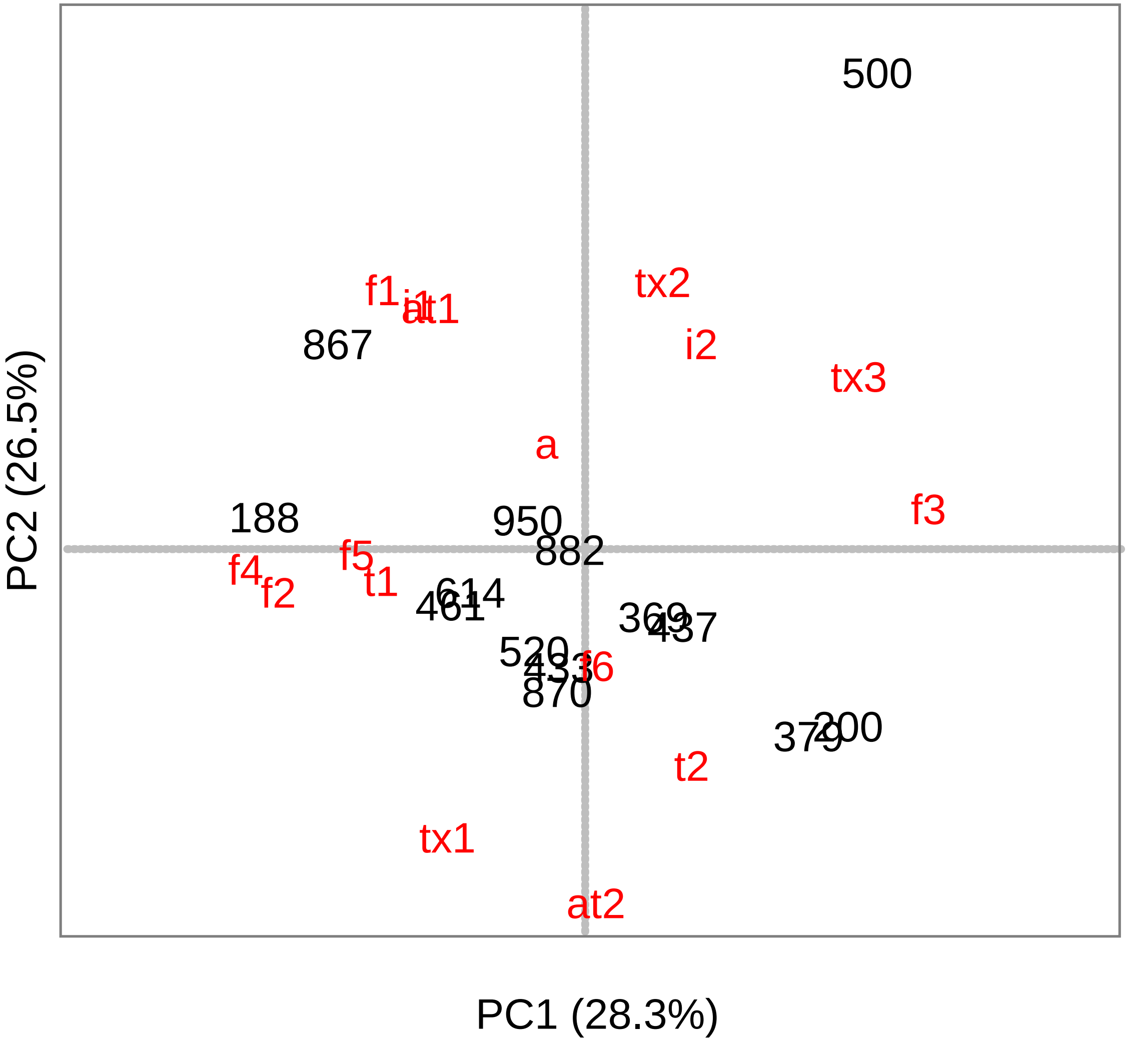
- Select consumers from the target user population
- Get good descriptive sensory data and analyze it well
- Get the experimental design from a good algorithm
- Do clustering and imputation properly
- Beware the R defaults, run many times with random starts

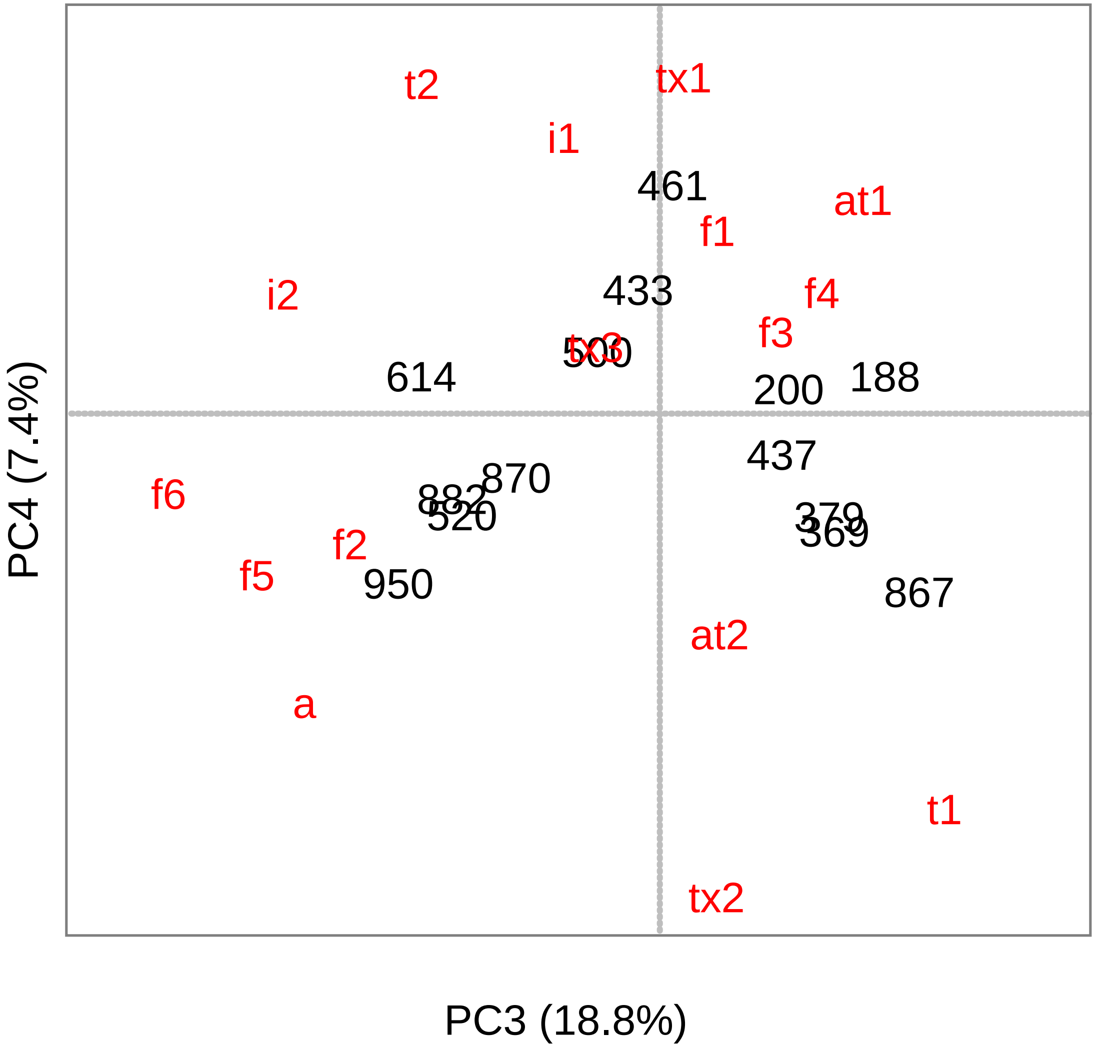
** quote from Warren Buffet*

The Workshop Data Set

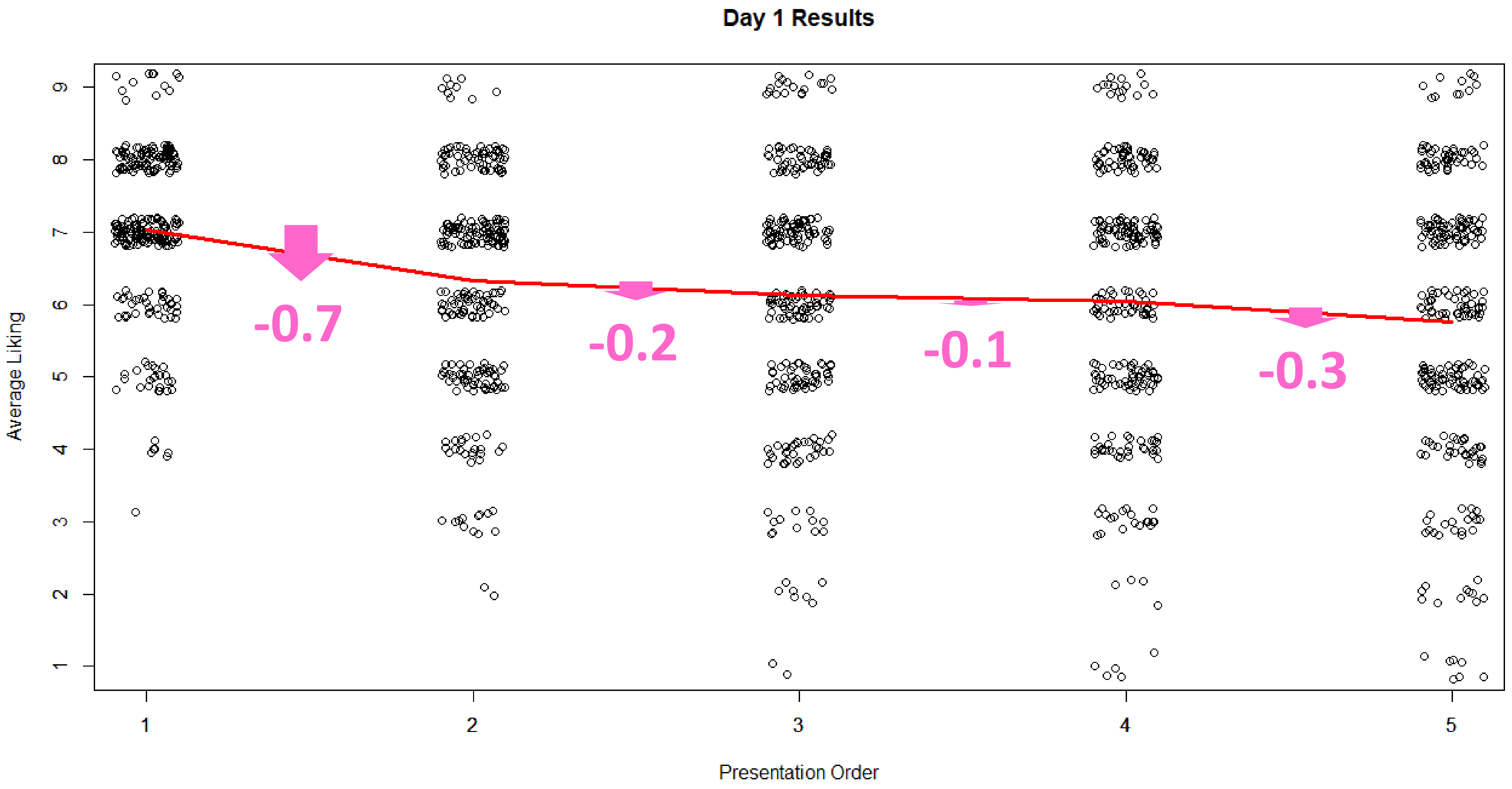
Spatial Sensory Segmentation

Sensory space





Order effects



Some ideas

Preference vs. Liking clusters
Compensation for order effects
High-contrast subsets vs. All subsets
Complete results vs. Day 1 (<1/3 of data)

References

Browne, R. P., McNicholas, P. D., & Findlay, C. J. (2013). A partial EM algorithm for clustering white breads. *arXiv preprint arXiv:1302.6625*.

Cleaver, G., & Wedel, M. (2001). Identifying random-scoring respondents in sensory research using finite mixture regression models. *Food Quality and Preference*, *12*(5-7), 373-384.

Danzart M., Sieffermann J.M., Delarue J. (2004). New developments in preference mapping techniques: finding out a consumer optimal product, its sensory profile and the key sensory attributes. *7th Sensometrics Conference*, July 27-30, 2004, Davis, CA.

Franczak, B. C., Browne, R. P., McNicholas, P. D., & Findlay, C. J. (2015). Product selection for liking studies: The sensory informed design. *Food Quality and Preference*, *44*, 36-43.

Franczak, B. C., Browne, R. P., McNicholas, P. D. (2020). sensory: Simultaneous Model-Based Clustering and Imputation via a Progressive Expectation-Maximization Algorithm. R package version 1.2. https://CRAN.R-project.org/package=sensory

Hottenstein, A. W., Taylor, R., & Carr, B. T. (2008). Preference segments: A deeper understanding of consumer acceptance or a serving order effect?. *Food Quality and Preference*, *19*(8), 711-718.

Le, S., & Husson, F. (2008). Sensominer: A package for sensory data analysis. *Journal of Sensory Studies*, *23*(1), 14-25.

McNicholas, P. D. (2016). *Mixture Model-Based Classification*. Chapman and Hall/CRC.

Meullenet, J. F., Xiong, R., & Findlay, C. J. (2008). *Multivariate and Probabilistic analyses of Sensory Science Problems* (Vol. 25). John Wiley & Sons.

Consumer hedonic studies with incomplete block designs

J. C. Castura
Compusense Inc.

Compusense®